

FIG 1

LISP S-expression

102

$(+ (* 5 (\text{sqrt } 4)) (/ 63))$

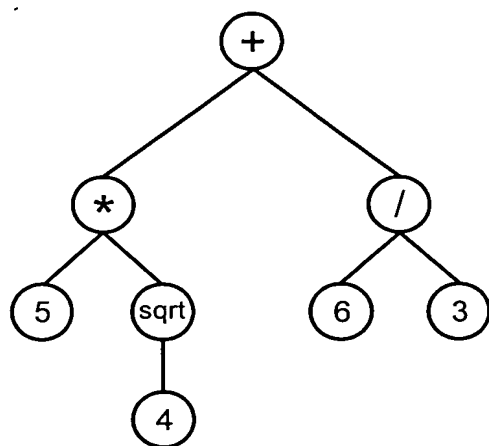
Conventional mathematical expression

101

$5 \cdot \sqrt{4} + \frac{6}{3}$

Tree representation

103



Coding region of a chromosome
of the present invention

104

+*/5Q634

105

009922070601

FIG 2

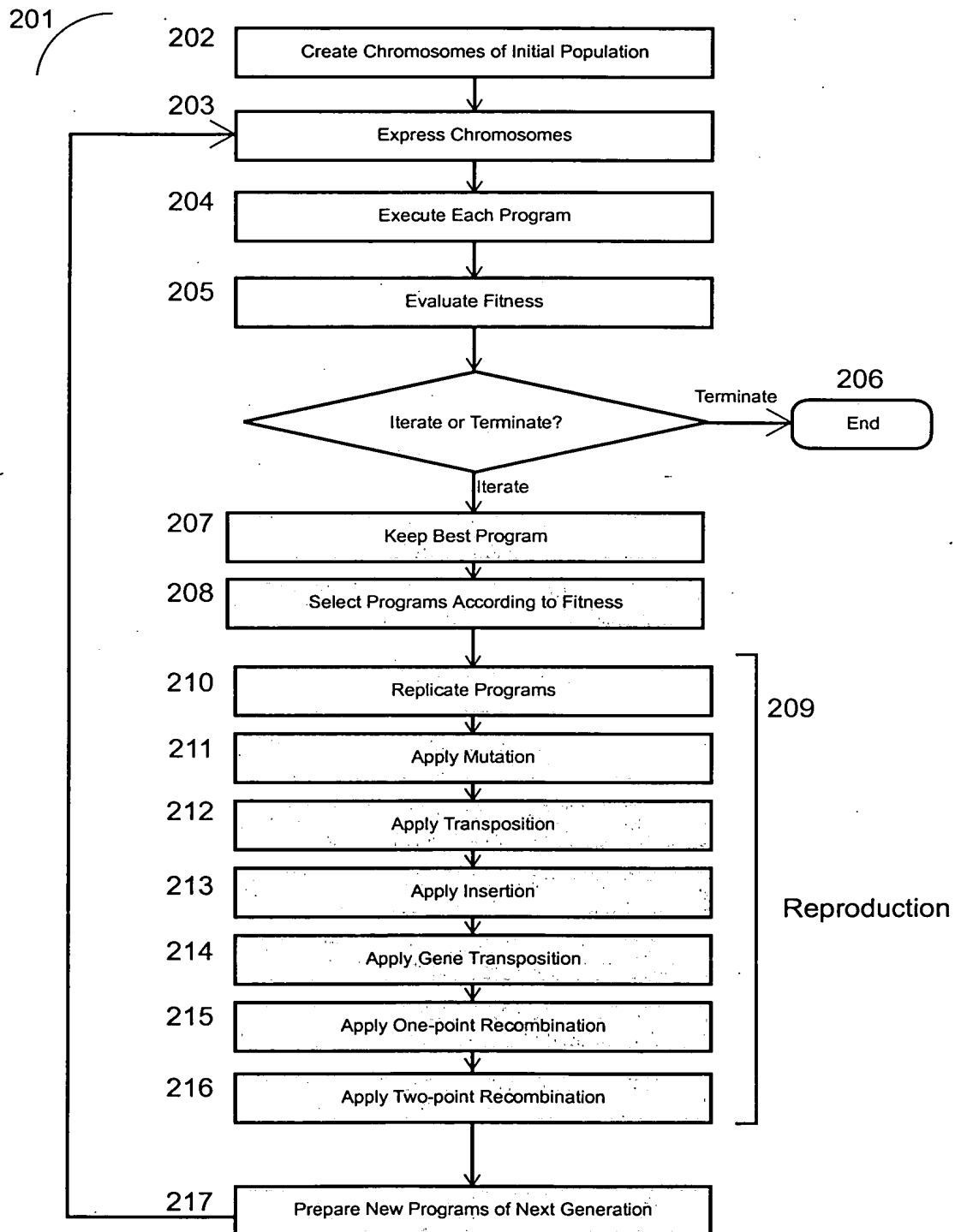
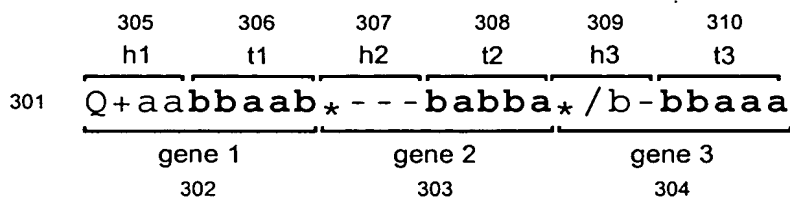
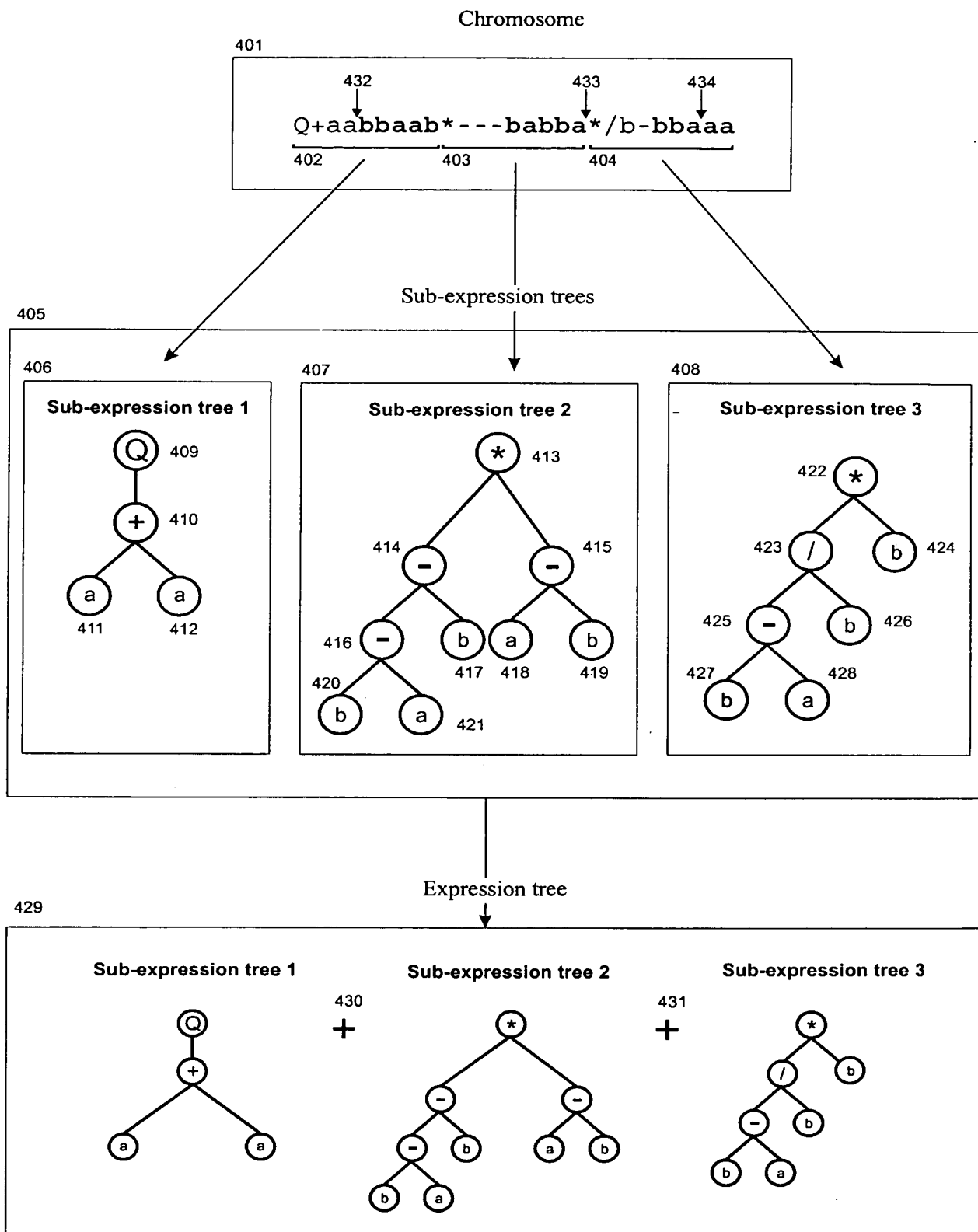


FIG 3



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FIG 4



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FIG 5

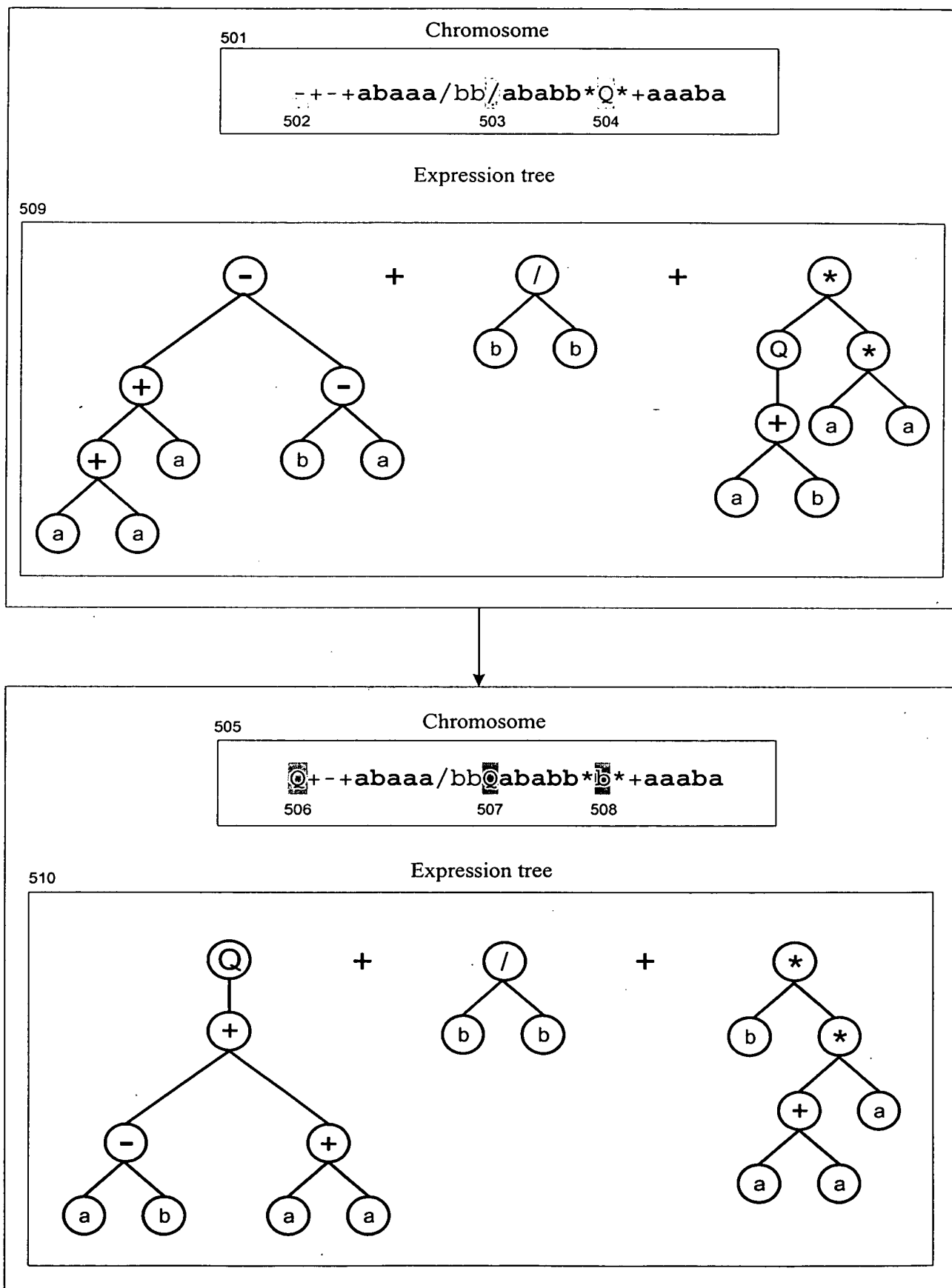


FIG 6

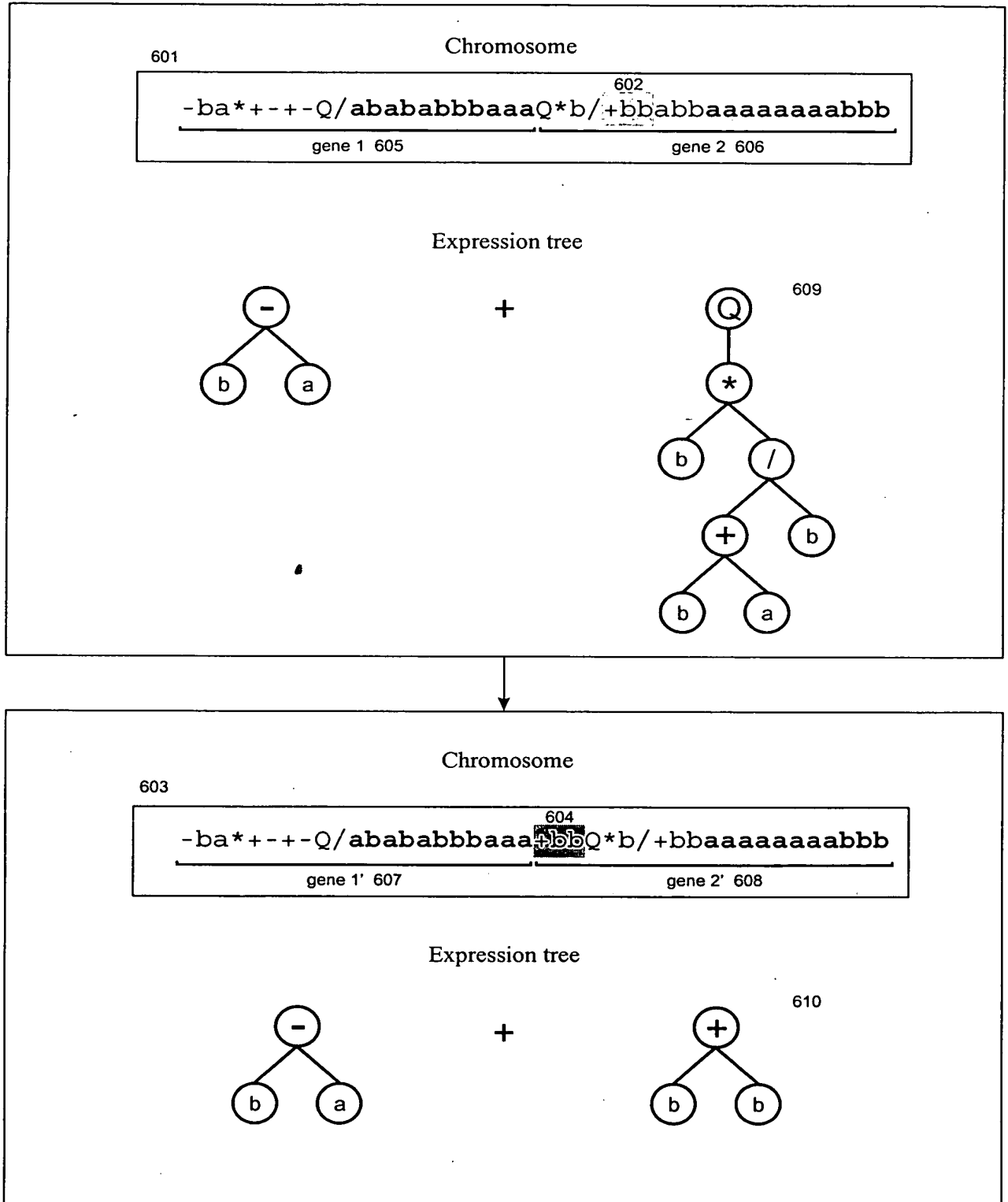


FIG 7

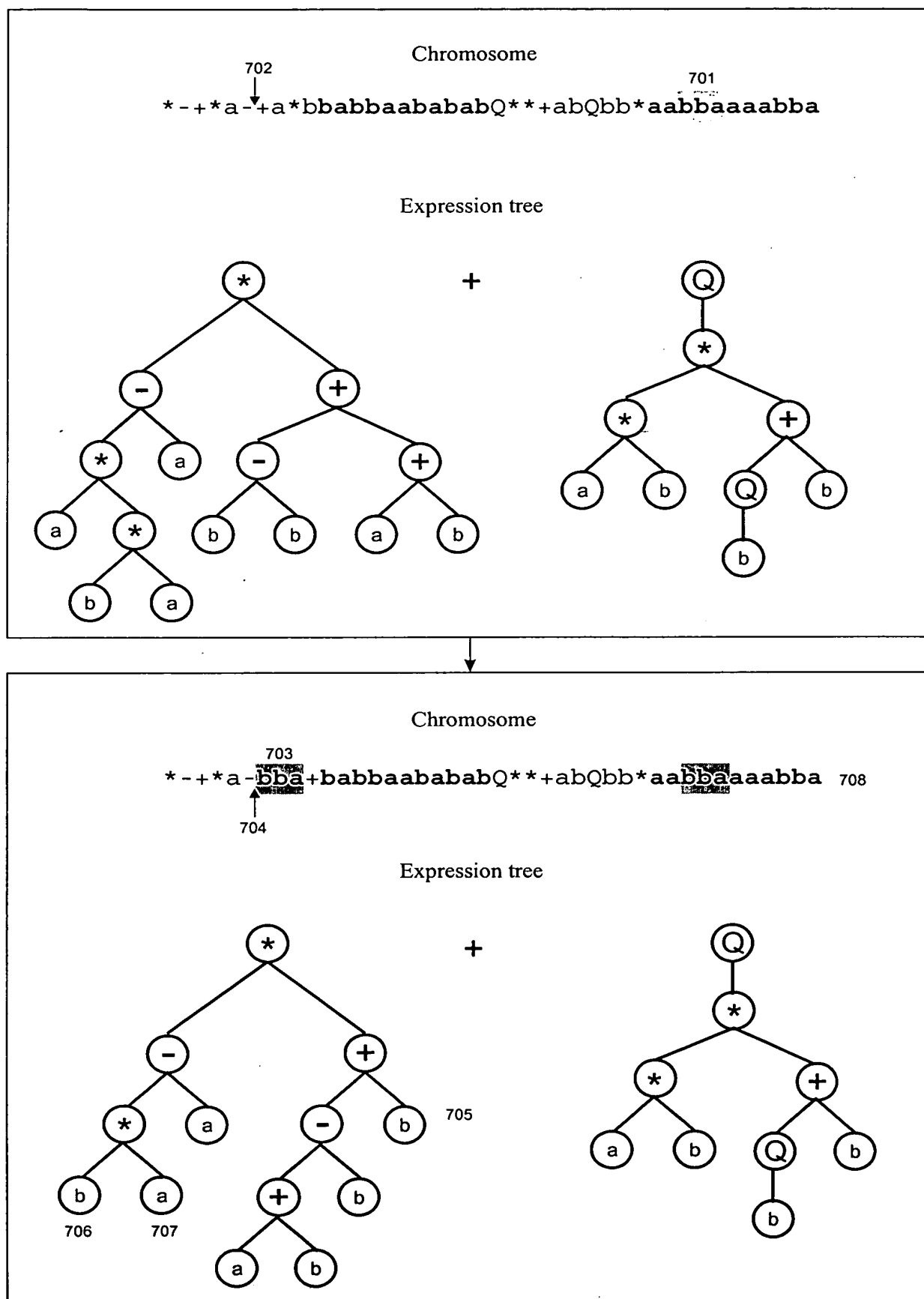
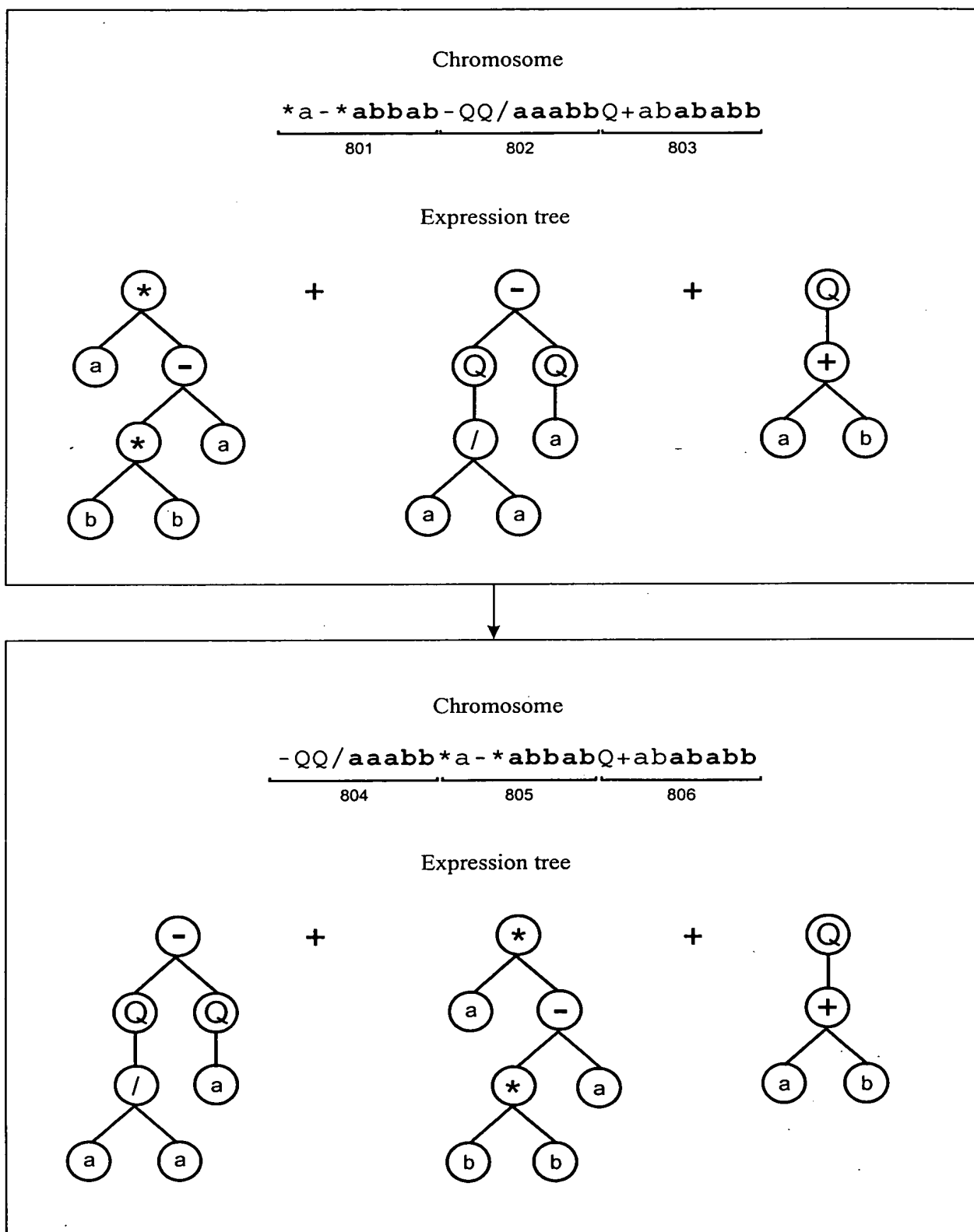


FIG 8



T09020" 28266860

FIG 9

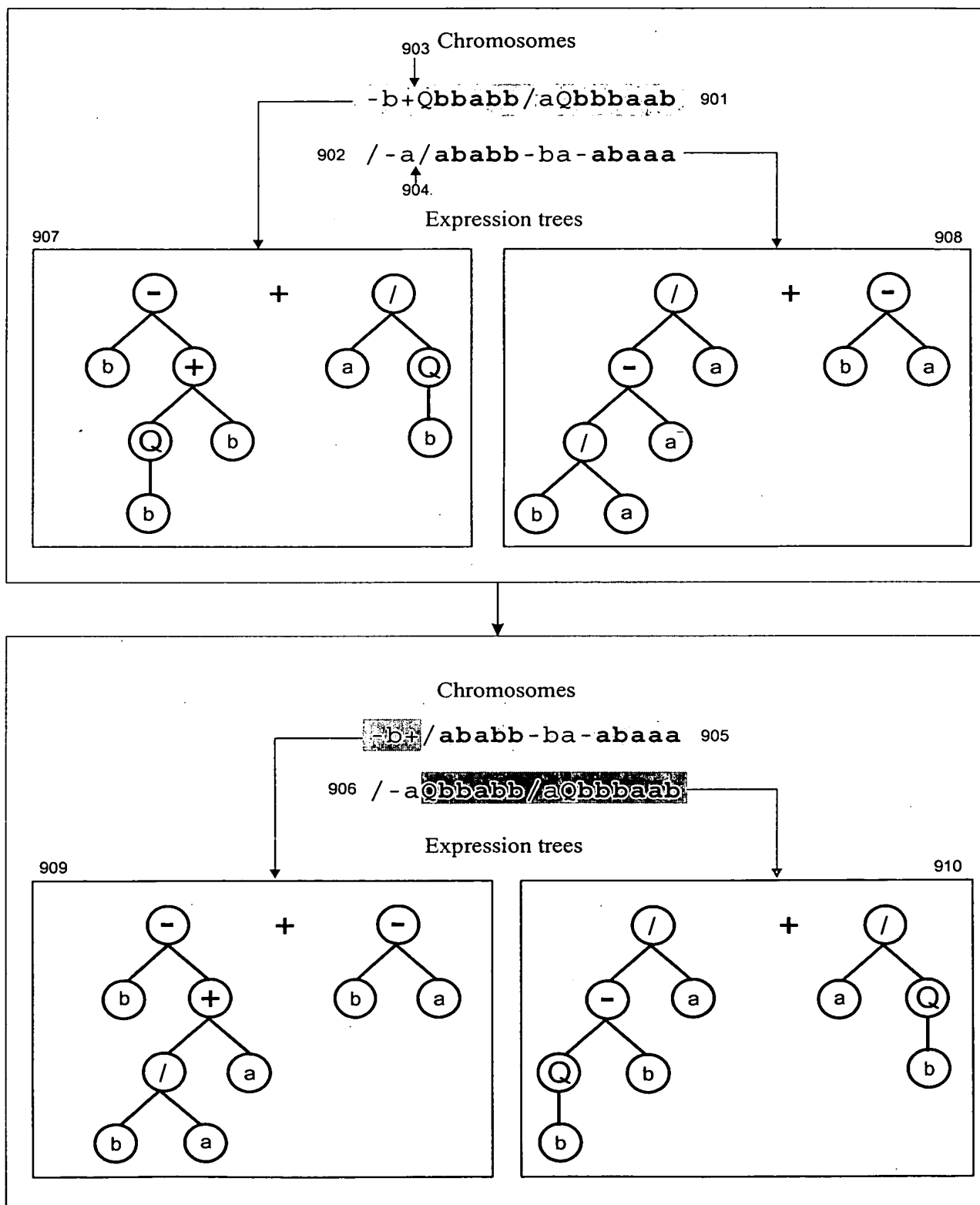
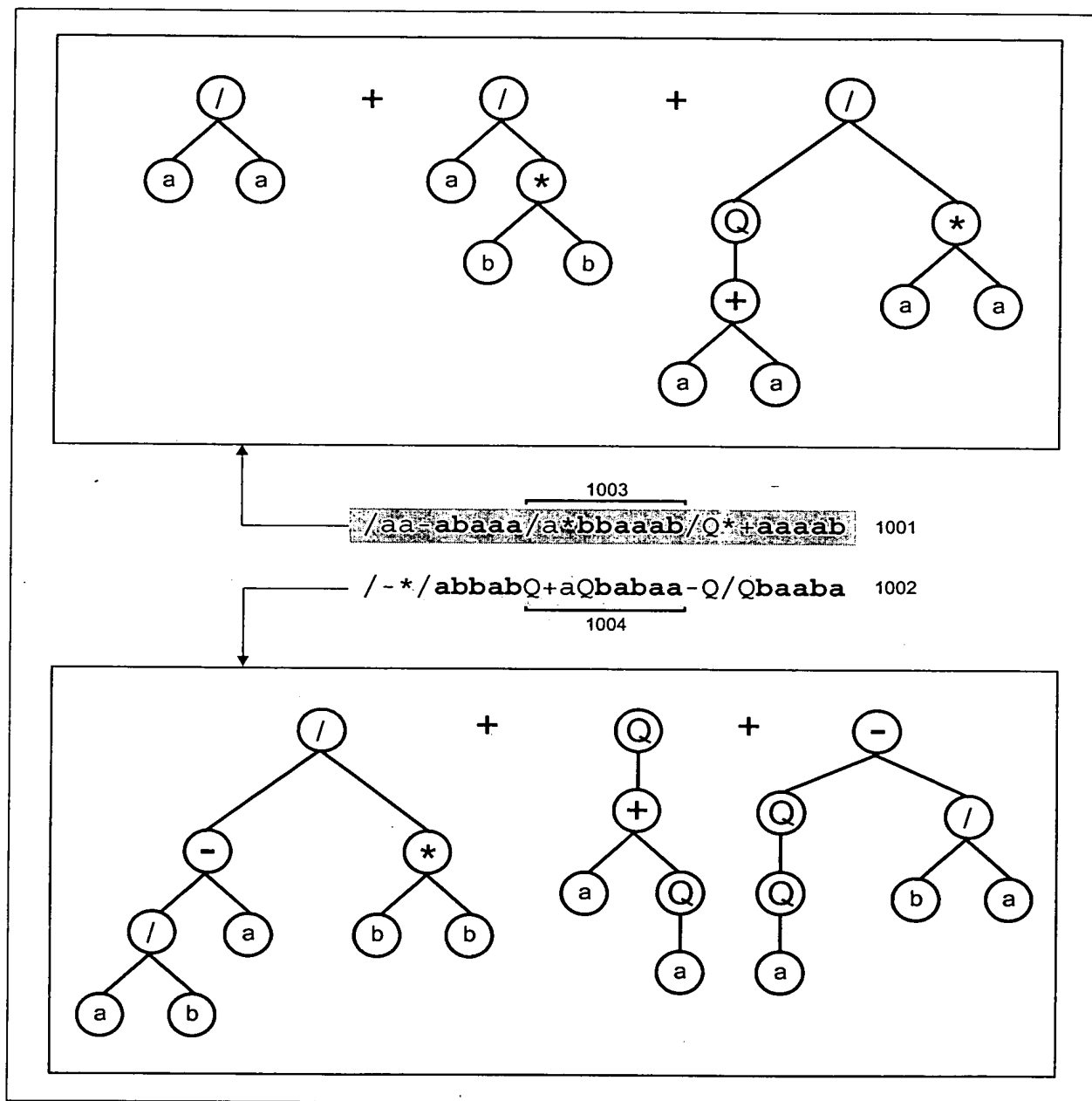
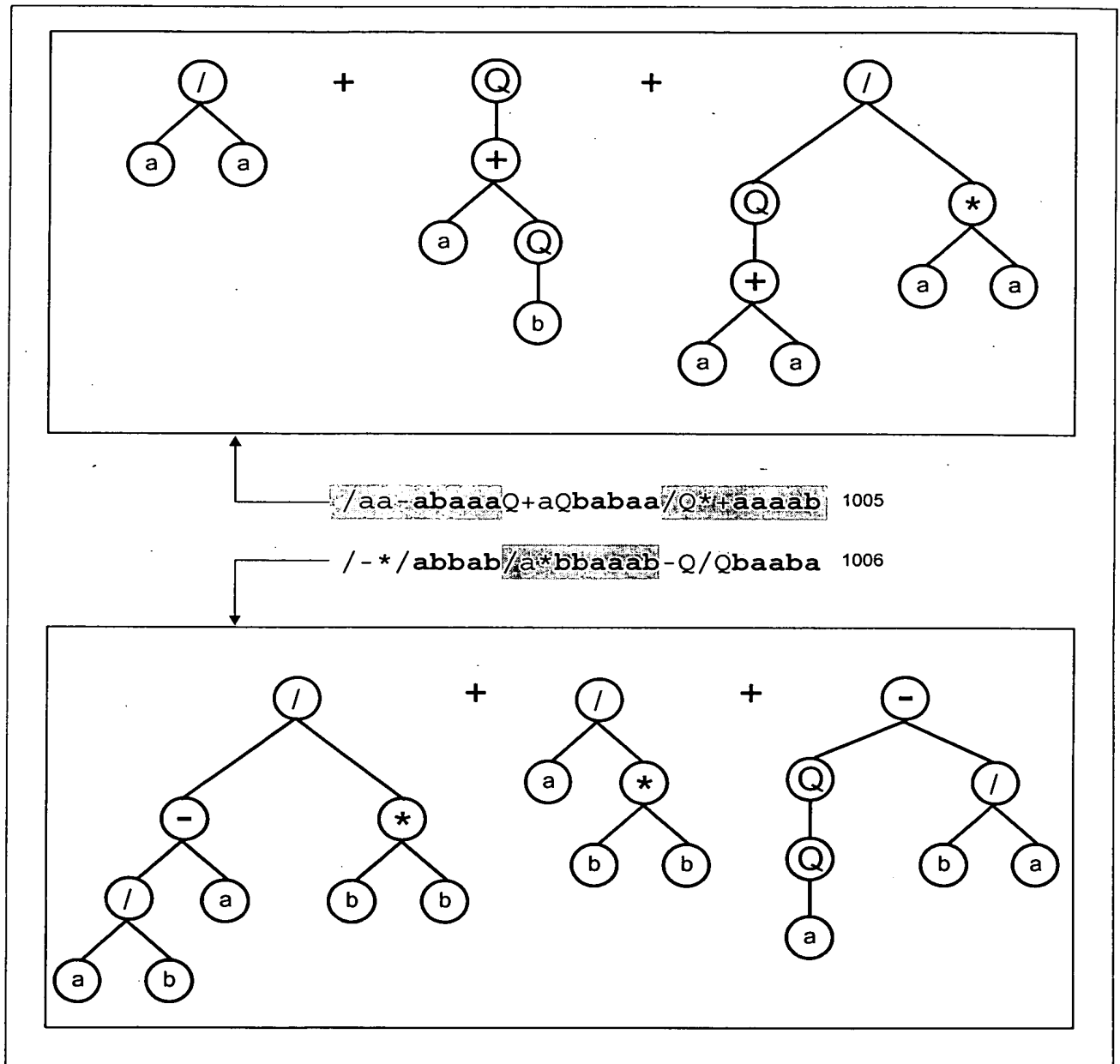


FIG 10A



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FIG 10B



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FIG 11

1101	Chromosomes	Fitness
	//*/-aaaaaa-----+aaaaaa*++*+aaaaaa*+++aaaaaa-[0] = 0	
	//+//aaaaaa+/*+/aaaaaa*-a-aaaaaa-a**+aaaaaa-[1] = 0	
	+a*+aaaaaa+---+aaaaaa*---aaaaaa*++*+aaaaaa-[2] = 73.35578	
	+*a*-aaaaaa/+a/aaaaaa-/+**+aaaaaa**/-aaaaaa-[3] = 0	
	/+/*+aaaaaa/a/+aaaaaa+/aa+aaaaaa*/-/aaaaaa-[4] = 26.6697	
	++/-aaaaaa/*-/aaaaaa*++*+aaaaaa/a*a-aaaaaa-[5] = 0	
	++//aaaaaa-a*+aaaaaa-/*//aaaaaa/++/*+aaaaaa-[6] = 25.44238	
	--+aaaaaa+a*+aaaaaa-a**+aaaaaa+/-*+aaaaaa-[7] = 0	
	-*a+-aaaaaa*a*+aaaaaa+*-a-aaaaaa//++aaaaaa-[8] = 22.67557	
	/+--+aaaaaa*a/*+aaaaaa/aa*+aaaaaa-*/a-aaaaaa-[9] = 0	
	+a/+aaaaaa++/-aaaaaa*+/*//aaaaaa-a-aaaaaa-[10] = 35.0658	
	-+a-aaaaaa*++*//aaaaaa-/+aaaaaa*a/+aaaaaa-[11] = 97.6903	
	/aa**+aaaaaa*+//aaaaaa/a**+aaaaaa+***//aaaaaa-[12] = 45.73774	
	-a-aaaaaa+/*+aaaaaa*-+*+aaaaaa--a-aaaaaa-[13] = 0	
	++*/-aaaaaa-a/a+aaaaaa*/-/aaaaaa/+--+aaaaaa-[14] = 0	
	++**//aaaaaa*/*//aaaaaa/a-aaaaaa--++*+aaaaaa-[15] = 0	
	/aa--aaaaaa-+*-/aaaaaa+**a/aaaaaa-/a+aaaaaa-[16] = 7.7575	
	++*-aaaaaa+*+-aaaaaa+a-+aaaaaa/a*-aaaaaa-[17] = 0	
	+++aaaaaa-/+*-aaaaaa-a/a+aaaaaa*+*-aaaaaa-[18] = 0	
	+a-+aaaaaa/a/+aaaaaa/*+*-aaaaaa*/a*/aaaaaa-[19] = 0	
	--a+-aaaaaa*a/a+aaaaaa+*//aaaaaa*a+/-aaaaaa-[20] = 21.5497	
	/++**+aaaaaa+ta+/aaaaaa*+--aaaaaa/+a+aaaaaa-[21] = 18.06512	
	/+aa-aaaaaa+//+aaaaaa*a+/-aaaaaa-*/-aaaaaa-[22] = 17.4636	
	/-/++aaaaaa/-+*+aaaaaa/a/-*+aaaaaa+--+aaaaaa-[23] = 0	
	++*-aaaaaa/*a-aaaaaa/-+aaaaaa+/-*//aaaaaa-[24] = 27.9458	
	-/---aaaaaa-a*+aaaaaa++++-aaaaaa-/a+aaaaaa-[25] = 0	
	+---aaaaaa/+/aaaaaa-a/a*+aaaaaa+*-a/aaaaaa-[26] = 18.2736	
	-*+a+aaaaaa/-/+aaaaaa*a*a+aaaaaa/-/a-aaaaaa-[27] = 80.0881	
	/-++-aaaaaa*+/-/aaaaaa/-+*+aaaaaa/-++*+aaaaaa-[28] = 0	
	+-*//aaaaaa-*--+aaaaaa/a/+aaaaaa*a+//aaaaaa-[29] = 31.31912	

Chromosome number

109070" 28265850

FIG 12

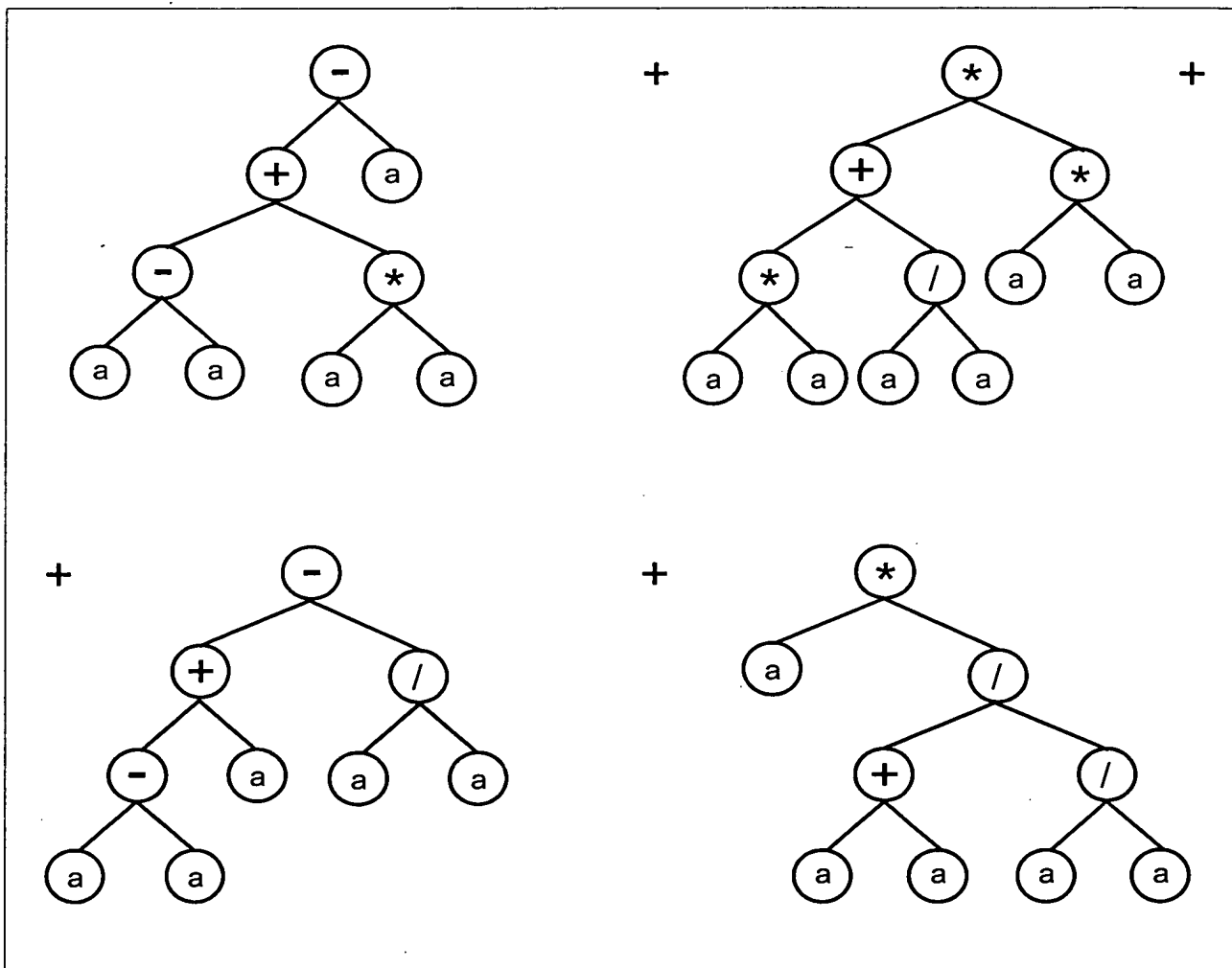
Chromosome

1201

-+a-*aaaaaa*+**/aaaaaa-+/-aaaaaaa*a/+/aaaaaa

Expression tree

1202



Mathematical expression

1203

$$y = (a^2 - a) + (a^4 + a^2) + (a - 1) + (2a^2) = a^4 + 4a^2 - 1$$

FIG 13

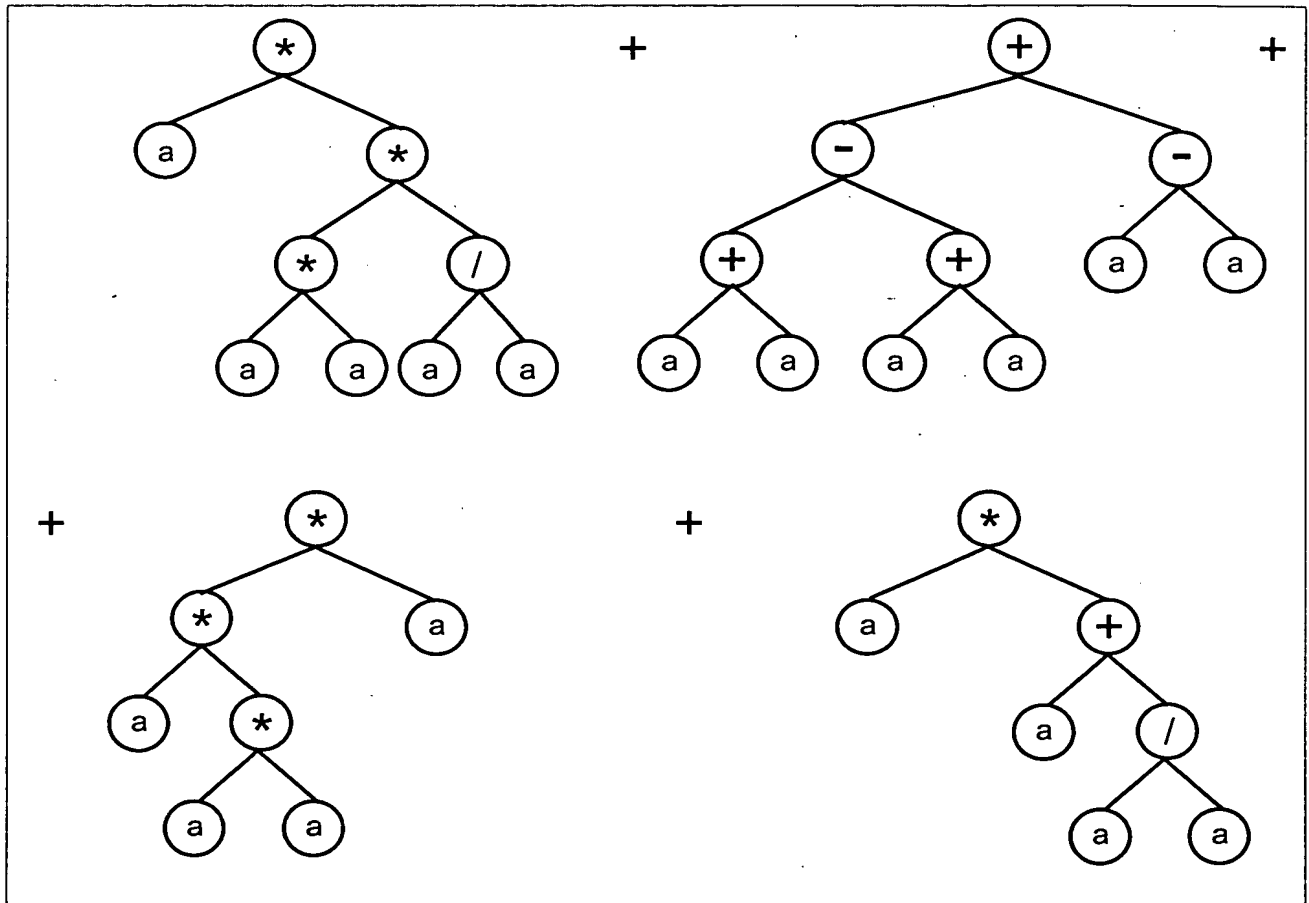
Chromosome

1301

*a** / aaaaaa+ - - + + aaaaaa * * a a * aaaaaa * a + a / aaaaaa

Expression tree

1302



Mathematical expression

1303

$$y = (a^3) + (0) + (a^4) + (a^2 + a) = a^4 + a^3 + a^2 + a$$

FIG 14

	Present Invention	Genetic Programming
G	50	51
P	30	500
C	10	20
P _s	1	0.35
R _z	1	11
F _z	15,000	5,610,000

109020" 28266860

Fitness cases' stacks

1503	Chromosomes	Fitness
	ApAAutputCuRuputptAttCtptuu- [0]	= 1
	ARRpttutpAAupupuupNCRNuttuu- [1]	= 0
	CCRApttttCAPNuptppRNAAttup- [2]	= 1
	ANpNttuptCARptutuuNRpAttuu- [3]	= 1
	ARCRtpptuRuuAppptpAttuptup- [4]	= 1
	ApuApuuutAARCutupuACNptpppu- [5]	= 0
	RARuputppCACApptupRRCNttutu- [6]	= 0
	AtAuppppuCuAtppptuNACAAttpp- [7]	= 1
	NtNAuputpACutppptuCuCRptppu- [8]	= 0
	NtANpptutAuRptpppuRpNAutupu- [9]	= 1
	AuututtuRptRptttuRAARutupt- [10]	= 0
	CpNRtuuupCCCCupptRptCuptuu- [11]	= 2
	RCNAuptutCACTutuupNRtNptut- [12]	= 1
	AApNuuttpANCuptutuRCAutptup- [13]	= 0
	CtCututtuCAAAutptuANRNuttpt- [14]	= 0
	CAApptutCatNutppuAtpAtutut- [15]	= 1
	NpAAuppupAAAuptpuuAttRtputt- [16]	= 1
	AAARttuuuNAARtppuuAutuutptp- [17]	= 1
	ApRAutptNNAAppppuActRptuup- [18]	= 0
	AAApppputRNACupptpACNttuptu- [19]	= 0
	CpRNppppuACANttuttNAAAutput- [20]	= 2
	AtNAutttAutptttuupARRCtupp- [21]	= 0
	CAAAtputuAtANptpupAAptpuut- [22]	= 1
	ARNRtuuupApAtttputApRNupuut- [23]	= 0
	RtNNtpuppCtAuuuppuCAANpuutu- [24]	= 0
	RCAtuupttAutAptutpAAtAtttuu- [25]	= 0
	RtAuputAAAptututRpRpptpuu- [26]	= 1
	CpAAtputuCCpNpttutAuRppupt- [27]	= 2
	AACRtpupuRuAAttuptCAuuppuuu- [28]	= 2
	RuAAputtuRACNuupptAuRppuupp- [29]	= 2

Chromosome number

FIG 16

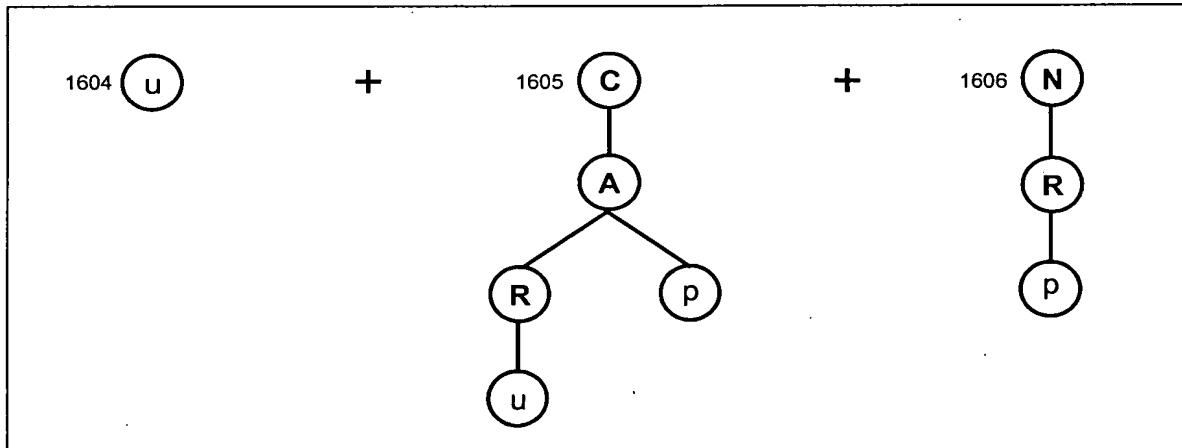
Fitness cases' stacks

1601
rilasnvu#-0
rls#####-1
anruievl-2
nr#####-3
viaslre##-4
ievlanru#-5
uenari###-6 — 1602
neai#####-7
li#####-8
#####-9

1603 Chromosome

uNpNttuptCARpuutupNRpCtutut

Expression tree



0999282 070601
T09040" 28266860

FIG 17

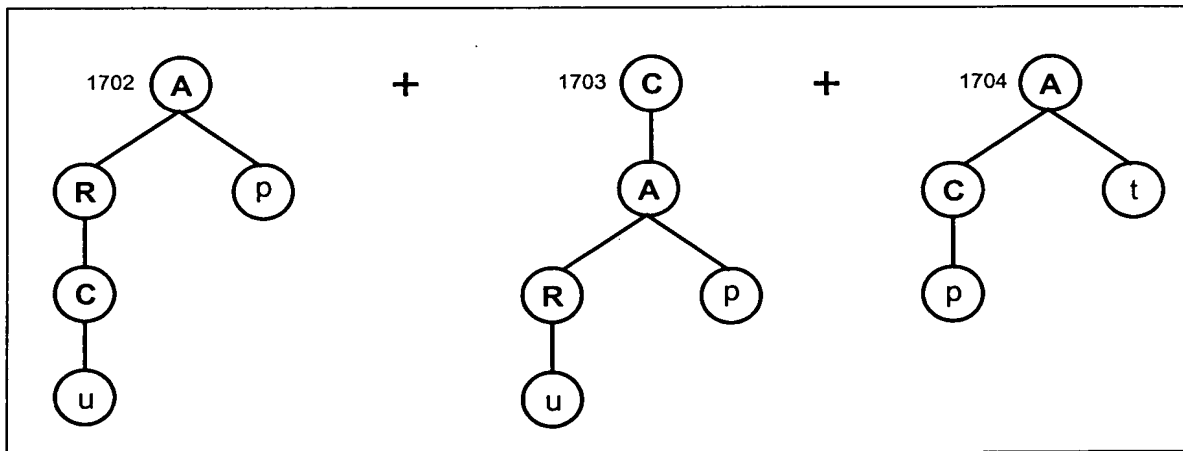
Fitness cases' stacks

s#####-0
 vulnsiaer-1
 iuvr#####-2
 riev#####-3
 ui#####-4
 isunrl###-5
 uniav####-6
 lireav###-7
 ni#####-8
 #####-9

1701 Chromosome

ARpCpUtutCARpuuuupACTptpuut

Expression tree



1701 1702 1703 1704

FIG 18

Fitness cases' stacks

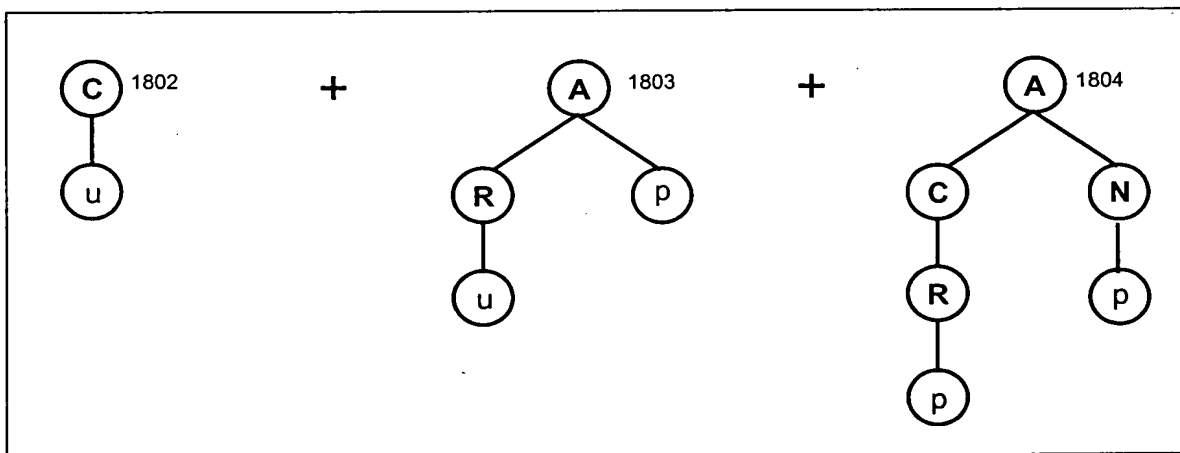
avnurle##-0
 vsrui####-1
 uerlvsnai-2
 saelnu###-3
 linv#####-4
 sivnrlaeu-5
 vulrsaine-6
 esla#####-7
 vnarlsei#-8
 #####-9

1801

Chromosome

CutputuptARpuuuttpACNRppuuu

Expression tree



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FIG 19

	Present Invention	Genetic Programming
G	100	51
P	30	500
C	10	167
P _s	0.70	0.767
R _z	4	4
F _z	120,000	17,034,000

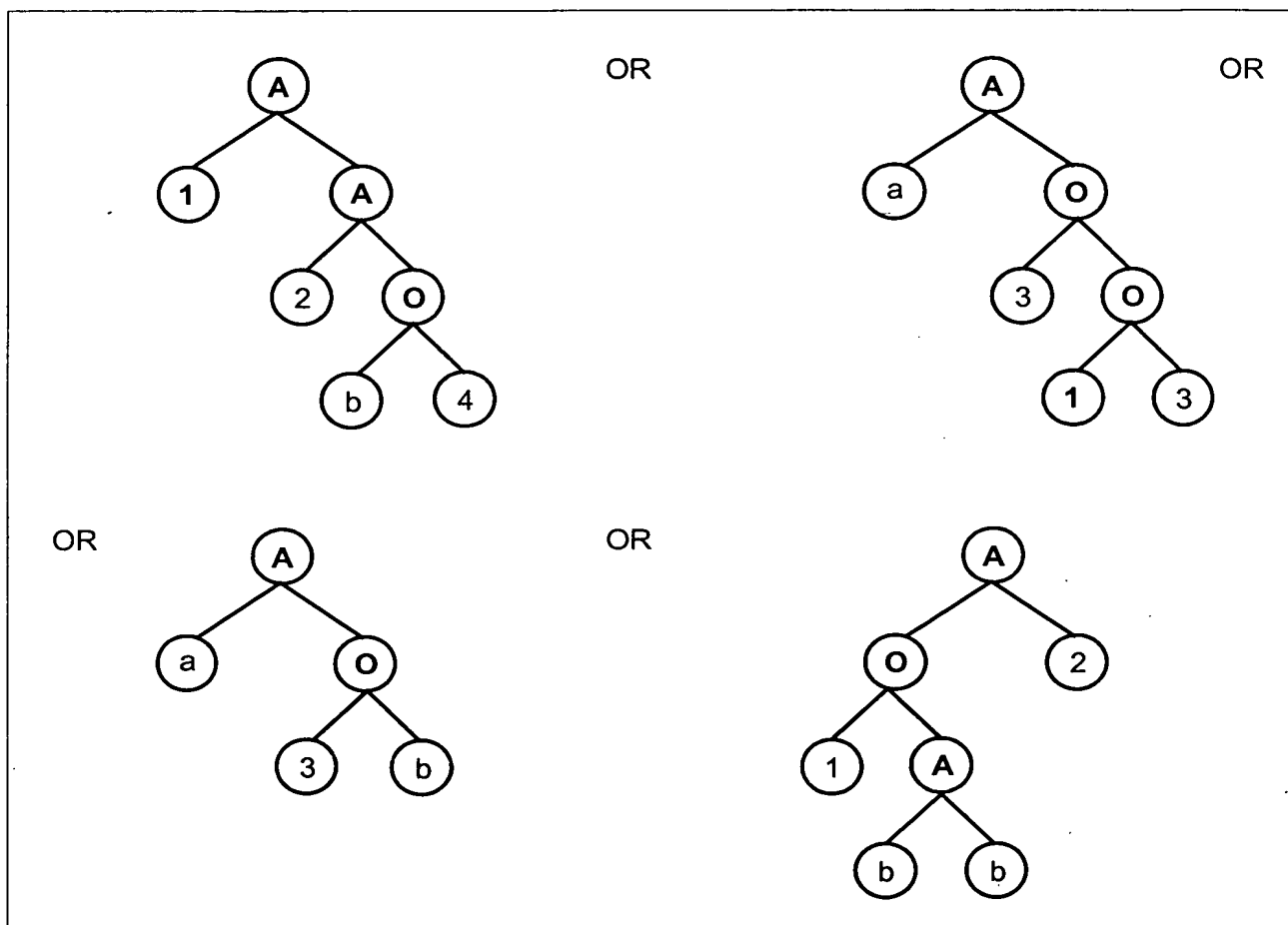
109020 23266860

2002

FIG 21

2101 Chromosome Fitness
 A1A2Ob4443aAa030133311Aa03bbbb322AO21Abb4a33 = 132

2102 Expression tree



109040" 28266860

7

2202

OR

OR

OR

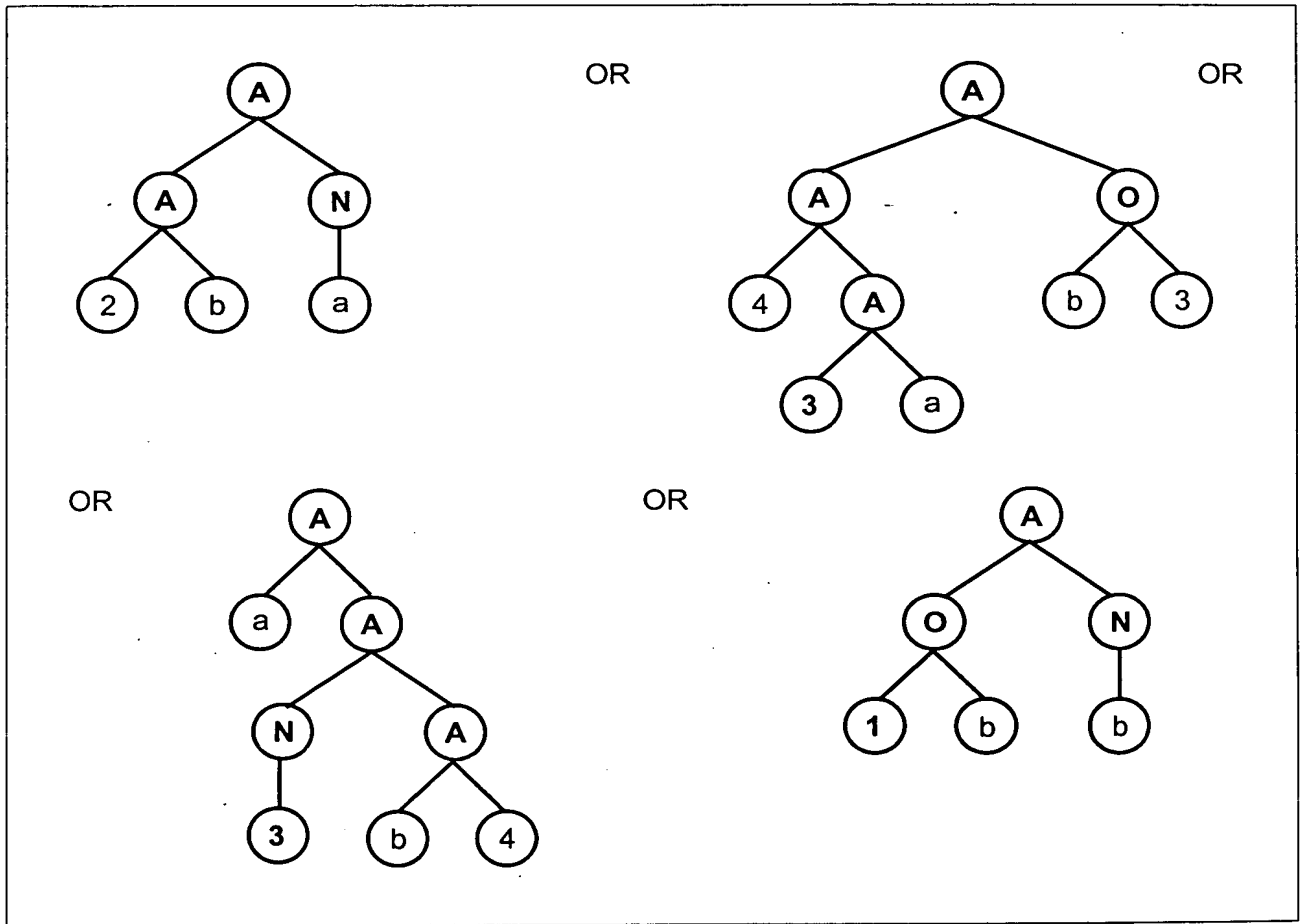


FIG 23

2301 Chromosome Fitness
 AAN2baa4b2bAAO4Ab33a31AaANA3b4312AON1bb1b233 = 310

2302

Expression tree



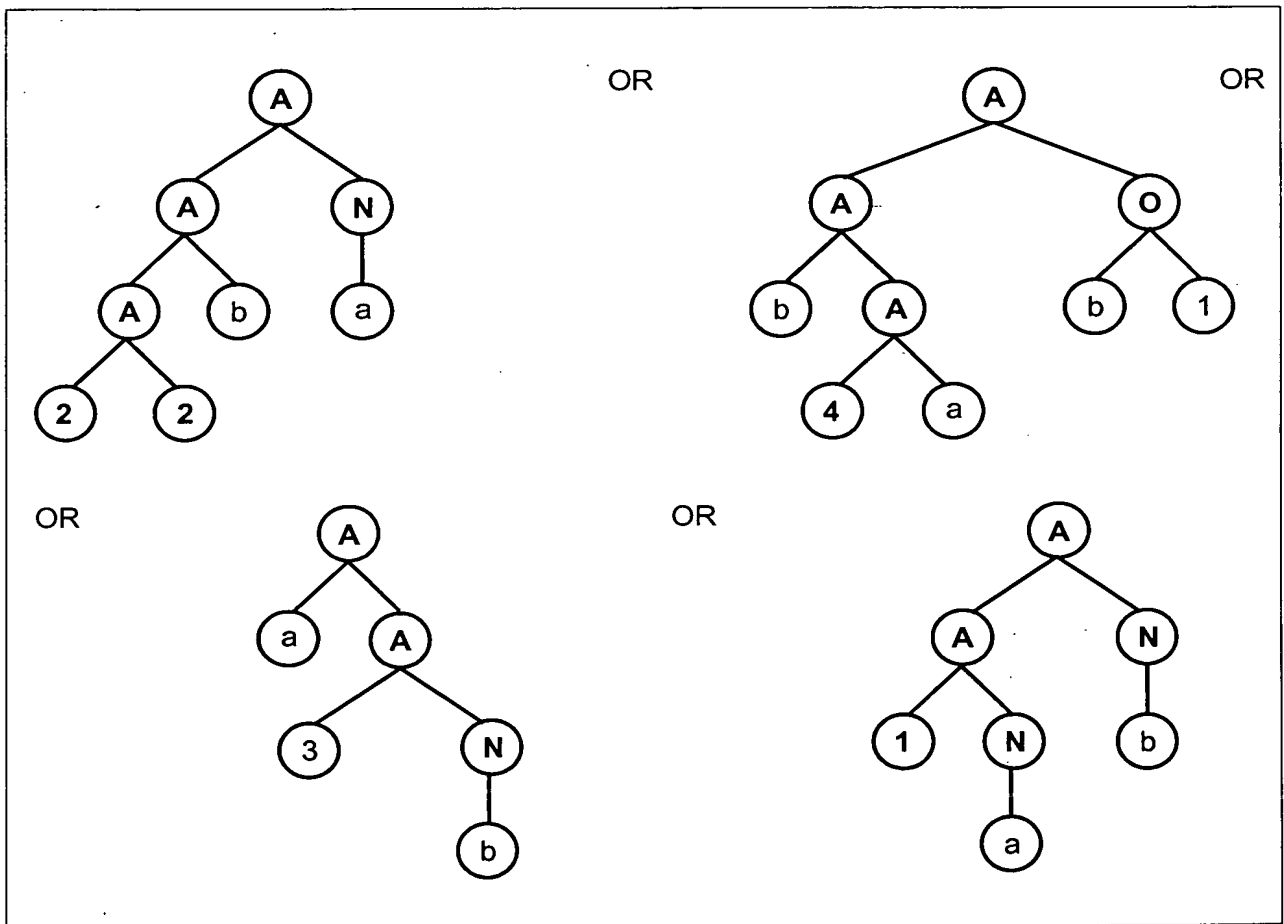
109070" 28266860

FIG 24

2401 Chromosome Fitness
 AANAb a22a41AAObAb14a2bAaA3Nba1111AAN1Nba2a2b = 400

2402

Expression tree



T09040" 28266860